Indian Journal of Weed Science **49**(3): 252–255, 2017
DOI: 10.5958/0974-8164.2017.00065.X

Efficacy of pre- and post-emergence herbicides for weed control in greengram

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Received: 4 July 2017; Revised: 16 August 2017

ABSTRACT

A field experiment was conducted during rainy seasons in 2011 and 2012 to study the efficacy of pre- and post-emergence herbicides on weeds, growth, symbiotic traits and grain yield of greengram. Pre-emergence application of pre-mix pendimethalin + imazethapyr at 1.0 kg/ha showed lowest weed index and highest weed control efficiency, followed by pre-mix pendimethalin + imazethapyr at 0.75 kg/ha and two hand weedings done at 20 and 40 days after sowing. Post-emergence application of quizalofop-ethyl at 37.5 g/ha reduced the number and dry weight of nodules/plant compared to other herbicides. Weed free treatment provided the highest grain yield, gross returns and net returns. Among the herbicides, pre-emergence application of pre-mix pendimethalin + imazethapyr at 1.0 and 0.75 kg/ha recorded higher grain yield (1.41 and 1.31 t/ha, respectively) and provided higher net returns (` 52970 and ` 48390, respectively) and B:C ratio (2.57 and 2.44, respectively) than the other treatments of herbicides due to significant reduction in the dry weight of weeds and higher weed control efficiency and consequently improving the yield attributing parameters.

Key words: Greengram, Imazethapyr, Nodulation, Pendimethalin, Post-emergence, Weeds

Greengram [*Vigna radiata* (L.) Wilczek], also known as mungbean, is grown in rainy season in many parts of India. Weeds are one of the most limiting factors in successful greengram production. Due to monsoon rainfall in rainy season, weeds grow luxuriantly and pose a serious threat to greengram. Weeds compete for nutrients, water, light and space with crop plants. Raising of greengram requires lot of labour due to more weeds and farmers generally do not harvest profitable yields. Weeds can cause 30-85% yield losses in greengram (Raman and Krishnamoorthy 2005, Yadav and Singh 2005, Mirjha *et al*. 2013). The effect of weed competition is greater during early growth period than the later one. Moreover, herbicides have also been reported for their negative effect on legume-*Rhizobium* interactions (Singh 2005) affecting either directly the rhizobial structure (Anderson *et al*. 2004) or indirectly reducing the photosynthate transport to the symbiotic organ ''nodules'' for N_2 fixation (Ahemad and Khan 2011).

Due to involvement of high cost and scarcity of labour for manual weeding, there is a need of evaluation of pre-emergence (PE) and post-emergence (PoE) herbicides in greengram for effective weed control. Therefore, an experiment was conducted to study the effect of pre- and post-emergence herbicides on weeds, growth, symbiotic traits and grain yield of greengram.

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MATERIALS AND METHODS

A field experiment was conducted during rainy seasons 2011 and 2012 at the research farm of Punjab Agricultural University, Ludhiana (30° 54'N, 75° 48'E, altitude 247 m), Punjab. The soil of the experimental site was loamy sand, having pH (7.8), organic carbon (0.29%), available phosphorus (11.5 kg/ha) and available potassium (196 kg/ha). Ten treatments, (**Table 1)**, were arranged in a randomized block design with three replications. Quizalofop-ethyl and fenoxaprop-ethyl were sprayed at 23 and 25 days after sowing (DAS) during 2011 and 2012, respectively and pendimethalin and pre-mix pendimethalin + imazethapyr as PE (within 24 hour of sowing) with a knapsack sprayer fitted with a flat fan nozzle using 375 litres of water per hectare. In the case of two hand weedings, weeds were removed manually with a a *khurpa* (kind of hand tool) at 20 and 40 DAS. In the case of weedy check plots, weeds were allowed to grow and in weed free plots, weeds were removed with *khurpa* during the whole crop growing season.

The preceding crop was wheat. After pre-sowing irrigation, at optimum soil moisture, the field was ploughed twice followed by planking. The crop was sown on 19 July, 2011 and 11 July, 2012. The sowing of greengram variety '*PAU 911*' was done in rows 30 cm apart using a seed rate of 20 kg/ha. Each plot measured 6.0 × 2.7 m in 2011 and 5.5 x 2.1 m in 2012. Data on weed species count were recorded at

40 DAS from a randomly selected area measuring 50 x 50 cm from each plot and then converted to weed species count per m^2. At harvest, weeds from the whole plot were harvested, dried and data converted into kg/ha. Data on symbiotic parameter *viz*. number and dry weight of nodules were recorded at 40 DAS. Five plants per plot were randomly selected for number and dry weight of nodules, and then average worked out.

At maturity, data on plant height, branches/plant and pods/plant were recorded from randomly selected five plants from each plot, and seeds/pod from randomly selected 20 pods. Biological yield and grain yield were recorded on the basis of whole plot area and converted into kg/ha. From the produce of each plot, 100-seeds were taken for 100-seed weight data. Harvest index (HI) was also calculated. Gross returns, net returns as well as benefit:cost (B:C) ratio were worked out using prevailing prices of inputs and output. Two-year pooled data were subjected to analysis of variance (ANOVA) in a randomized block design as per the standard procedure.

RESULTS AND DISCUSSION

Effect on weeds

During the period of experimentation, the major weed flora emerged were *Cyperus rotundus* (nut grass), *Eleucine aegyptiacum* (crow foot grass) and *Commelina benghalensis* (day flower) (**Table 1**). In general, weedy check, fenoxaprop-ethyl and quizalofop-ethyl recorded higher weed density whereas pre-mix application of pendimethalin + imazethapyr at 0.75 and 1.0 kg/ha recorded lower weed density than other treatments.

Pre-mix application of pendimethalin + imazethapyr at 0.75 and 1.0 kg/ha caused significant reduction in the dry weight of weeds followed by two hand weedings and pendimethalin at 0.45 kg/ha + hand weeding (**Table 1**). However, application of post-emergence herbicides quizalofop-ethyl at 37.5 g/ha and fenoxaprop-ethyl at 50 g/ha did not control the weeds effectively.

Quizalofop-ethyl at 37.5 g/ha and fenoxaprop-ethyl at 50 g/ha recorded low weed control efficiency (WCE) as these treatments did not control weeds effectively (**Table 1**). PE application of pre-mix pendimethalin + imazethapyr at 0.75 and 1.0 kg/ha recorded higher WCE as compared to pendimethalin alone at the same rates of application. This could be due to better weed control owing to two different chemicals. Application of imazethapyr has been reported to provide effective control of weeds in greengram (Khairnar and Sethi 2014, Singh *et al*. 2014a, Singh *et al*. 2015, Kumar *et al*. 2016), blackgram (Aggarwal *et al*. 2014) and lentil (Singh *et al*. 2014b). Khairnar and Sethi (2014) also reported higher WCE with the application of imazethapyr. Reduction of dry matter of weeds with the application of pendimethalin has also been reported by several researchers (Sekhon *et al.* 1996, Kaur *et al.* 2010, Singh 2011, Aktar *et al.* 2015). Among different weed control treatments, PE application of pre-mix pendimethalin + imazethapyr at 1.0 kg/ha showed lowest weed index followed by pendimethalin + imazethapyr at 0.75 kg/ha and two hand weedings.

Effect on crop

Number and dry weight of nodules were the lowest in weedy check (**Table 2**). Application of quizalofop-ethyl at 37.5 g/ha recorded lower number and dry weight of nodules/plant than the other herbicide treatments and these were significantly lower than hand weeding treatment. Ahemad and

Table 1. Population of different weed species, dry weight, weed control efficiency and weed index as influenced by different weed control treatments in greengram (pooled data of 2 years)

Treatment	At 40 DAS weed count (no./m^2)			At harvest		
	Cyperus rotundus	*Eleucine aegyptiacum*	*Commelina benghalensis*	Dry weight of weeds (kg/ha)	Weed control efficiency (%)	Weed index (%)
Pendimethalin at 0.45 kg/ha (PE) *fb* HW at 25-30 DAS	4.2 (18.0)	2.3 (5.4)	2.2 (4.6)	15.7 (247)	93.1	26.8
Pendimethalin at 0.75 kg/ha (PE)	4.0 (16.0)	2.0 (4.1)	2.6 (6.6)	22.9 (527)	85.3	31.2
Pendimethalin at 1.0 kg/ha (PE)	4.1 (16.6)	1.8 (3.4)	2.7 (7.4)	20.5 (420)	88.2	35.7
Pendimethalin + imazethapyr at 0.75 kg/ha (PE)	2.3 (5.4)	1.2 (1.4)	1.0 (0)	13.7 (189)	94.8	12.7
Pendimethalin + imazethapyr at 1.0 kg/ha (PE)	2.0 (4.0)	1.0 (0)	1.0 (0)	13.1 (173)	95.2	5.9
Quizalofop-ethyl at 37.5 kg/ha 23-25 DAS (PoE)	5.9 (34.7)	5.0 (25.4)	2.7 (7.4)	34.5 (1187)	66.3	68.4
Fenoxaprop-ethyl at 50 g/ha 23-25 DAS (PoE)	6.4 (40.7)	4.8 (22.6)	3.1 (9.4)	28.5 (814)	77.0	56.9
Weedy check	6.6 (43.9)	5.1 (26.0)	2.9 (8.6)	59.3 (3520)	-	66.4
Hand weeding (20 and 40 DAS)	2.6 (6.6)	2.3 (5.4)	1.4 (2.0)	16.6 (277)	92.3	15.7
Weed free	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	100.0	0.0
LSD (p=0.05)	2.6	2.2	1.1	13.8	17.0	18.7

Figures in parentheses are means of original values and subjected to square root transformation

Khan (2010) also reported the negative effects of quizalofop-p-ethyl on the symbiosis in greengram plants and the effects enhanced gradually with the increase in dose of the herbicide.

Different treatments of weed control did not influence the plant height, branches/plant and 100-seed weight significantly (**Table 2**). Treatments of weed free, two hand weedings and pendimethalin + imazethapyr at 0.75 and 1.0 kg/ha recorded higher number of pods/plant than other treatments. Seeds/pod was the lowest in weedy check.

Weed free recorded the highest biological yield and grain yield (**Table 3**). Weedy check treatment recorded the lowest biological yield and grain yield, which might be due to more weed density and dry weight of weeds and poor nodulation. Among the herbicide treatments, application of pre-mix pendimethalin + imazethapyr at 1.0 and 0.75 kg/ha recorded significantly higher grain yield than the other treatments of herbicides. Higher grain yield in these treatments was due to more number of pods/plant, which might have been resulted due to better control of weeds by reducing the dry matter of weeds and enhancing the WCE. Harvest index was higher in those treatments where weeds were effectively controlled. Quizalofop-ethyl at 37.5 g/ha, fenoxaprop-ethyl at 50 g/ha and weedy check recorded low harvest index.

Pendimethalin improved the grain yield significantly over weedy check (**Table 3**). Pendimethalin is known to improve the grain yield of greengram (Kaur *et al.* 2010) and blackgram (Singh 2011). However, application of pre-mix pendimethalin + imazethapyr showed significant superiority over the sole application of pendimethalin, which could be due to better weed control owing to two different chemicals.

Economics of different weed control treatments (**Table 3**) showed that weed free gave the maximum gross returns and net returns, followed by pre-mix application of pendimethalin + imazethapyr at 1.0 kg/ha and 0.75 kg/ha. Pre-mix application of pendimethalin + imazethapyr 1.0 kg/ha gave the highest B:C ratio followed by pendimethalin +

Table 2. Influence of different weed control treatments on the symbiotic traits, plant characters and yield attributes of greengram (pooled data of 2 years)

Treatment	Number of nodules/ plant at 40 DAS	Dry weight of nodules (mg/plant) at 40 DAS	Plant height (cm)	Branches / plant	Pods/ plant	Seeds/ pod	100-seed weight (g)
Pendimethalin at 0.45 kg/ha (PE) *fb* HW 25-30 DAS	31.9	56.1	62.5	4.8	19.7	10.6	3.25
Pendimethalin at 0.75 kg/ha (PE)	31.8	53.6	62.3	4.8	18.6	10.8	2.99
Pendimethalin at 1.0 kg/ha (PE)	28.6	51.1	58.6	4.6	18.7	10.5	3.05
Pendimethalin + imazethapyr at 0.75 kg/ha (PE)	31.1	53.1	63.5	4.9	21.9	11.3	3.10
Pendimethalin + imazethapyr at 1.0 kg/ha (PE)	32.3	58.3	65.3	4.9	24.1	11.6	3.22
Quizalofop-ethyl at 37.5 kg/ha 23-25 DAS (PoE)	26.4	45.2	60.5	4.5	15.8	10.8	3.08
Fenoxaprop-ethyl at 50 g/ha 23-25 DAS (PoE)	31.2	51.3	61.6	4.8	14.8	10.3	3.23
Weedy check	22.5	43.6	54.1	4.3	16.0	9.9	2.87
Hand weeding (20 and 40 DAS)	30.7	51.0	61.8	5.1	22.8	11.4	3.20
Weed free	29.0	57.4	61.5	5.4	24.3	11.4	3.27
LSD (p=0.05)	3.1	5.2	NS	NS	4.6	0.5	NS

Table 3. Influence of different weed control treatments on biological yield, grain yield, harvest index and economics of greengram (pooled data of 2 years)

Treatment	Grain yield (t/ha)	Biological yield (t/ha)	Harvest index (%)	Gross returns (x10^3 `/ha)	Net returns (x10^3 `/ha)	B:C ratio
Pendimethalin at 0.45 kg/ha (PE) *fb* HW 25-30 DAS	1.09	5.46	20.2	57.03	36.54	1.79
Pendimethalin at 0.75 kg/ha (PE)	1.03	4.92	21.6	53.79	35.01	1.87
Pendimethalin at 1.0 kg/ha (PE)	0.97	4.71	20.8	50.71	31.56	1.65
Pendimethalin + imazethapyr at 0.75 kg/ha (PE)	1.31	5.01	26.1	68.26	48.39	2.44
Pendimethalin + imazethapyr at 1.0 kg/ha (PE)	1.41	5.85	24.3	73.62	52.97	2.57
Quizalofop-ethyl at 37.5 kg/ha 23-25 DAS (PoE)	0.48	3.81	13.2	25.08	6.26	0.34
Fenoxaprop-ethyl at 50 g/ha 23-25 DAS (PoE)	0.66	4.39	15.0	34.67	15.57	0.82
Weedy check	0.51	3.05	16.6	26.67	10.75	0.68
Hand weeding (20 and 40 DAS)	1.26	5.26	23.9	65.65	45.72	2.30
Weed free	1.50	5.90	25.5	78.64	54.71	2.29
LSD (p=0.05)	0.23	1.33	3.9	11.93	11.93	0.63

imazethapyr 0.75 kg/ha, two hand weedings and weed free. Higher economic returns in these treatments could be due to higher grain yields as well as cost effectiveness for controlling weeds.

It was concluded that pre-mix application of pendimethain + imazethapyr at 0.75 or 1.0 kg/ha as pre-emergence effectively controlled the weeds, improved the grain yield of greengram and provided high net returns and B:C ratio.

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